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(54) **Absorbent foam products, process and compositions for immobilisation of particulate absorbents**

(57) A foam product having both absorptive and cushioning properties is prepared from 25-125 parts by wt of a solid, particulate, water-insoluble, water-swellaable polymer having a gel capacity of at least 10, provided that the polymer is not a hydrolysed starch polyacrylonitrile graft copolymer, 2-30 parts of a blowing agent, and 100 parts of a liquid polyhydroxy organic compound having vicinal hydroxy groups. Foamable compositions and articles employing the foam are also described.

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## SPECIFICATION

**Absorbent foam products, process and compositions for immobilization of particulate absorbents**

- 5 The present invention relates to absorbent foam products, compositions and methods for immobilizing particulate absorbents and absorbent articles produced therefrom.
- Absorption of mobile aqueous liquids have conventionally been accomplished by the use of sponge or batting. More recently, water-insoluble but water-swella-  
 10 ble polymers have been developed for immobilizing water and aqueous fluids. These polymers are particulate, i.e., pulverulent or granular and have no structural integrity. They are frequently referred to in the art as "superabsorbents," "hydrogels" or "hydrocolloids" and have been incorporated in the cellulosic absorbent structure in diapers, sanitary napkins and other  
 15 absorbent articles to increase their absorptive efficiency. The expected advantage of incorporating these particulate materials is diminished by the shifting of the particulate materials generally requiring special construction to immobilize them within the structure of the articles. A process for decreasing the mobility of particulate absorbent materials and products in which the particulate absorbents are uniformly retained is desirable. In U.S. 3,900,030, there is described a catamenial tampon which utilizes an open-celled polymer foam which has the water-swella-  
 20 ble polymers imbedded therein. While this provides structural integrity to the absorbent polymer, versatility in application is governed by the foam carrier. Moreover, the method of disposition is dictated by the foam carrier.
- In accordance with the present invention there is provided an absorbent-immobilizing foam-forming composition in liquid form, for use in preparing a product capable of absorbing and  
 25 retaining large quantities of liquid, comprising:
- a) at least 25 to no greater than 125 parts by weight of a particulate water-insoluble, water-swella-  
 30 ble absorbent polymer having a gel capacity of at least ten, provided that the polymer is not a hydrolysed starch/polyacrylonitrile graft copolymer;
  - b) 100 parts by weight of a liquid polyhydroxy organic compound having vicinal hydroxy  
 groups; and
  - c) 2 to 30 parts by weight of a blowing agent.
- Preferably, from 40 to 80 parts by weight of the polymer absorbent are employed for every  
 100 parts by weight of the liquid polyhydroxy organic compound.
- The absorbent-immobilizing composition (a) may be cast, coated or cold extruded on an  
 35 appropriate surface to obtain free films or sheets, (b) may be coated on the ultimate surface e.g. a substrate to form a film coating or (c) may be foamed in place. The products have structural integrity on solidification, have superior absorptive efficiency, are self-supporting, and are de-  
 gradably disposable as hereinafter described.
- The absorbent products are structurally stable solids, resilient and somewhat elastic, which  
 40 rapidly swell on absorption of fluid. They have the property of being degradable in large excess of water to water-dispersible particles, providing a convenient means for disposition after the desired function has been accomplished. The absorbent product differs from conventional  
 45 sponge or solid foam in having an extremely high capacity for absorbing aqueous fluids, being limited by the absorptive capability of the polymer absorbent and not by the dimensions of the original foam structure. The products are also advantageous in being easily prepared from a  
 50 non-toxic liquid foam-forming composition which is readily manageable without the necessity of adding water or organic solvent. Absorbent articles having particulate absorbents immobilized by an absorbent-bearing solidified structure according to the present invention have high absorptive  
 capacities which are not diminished by shifting and bunching of particulate absorbents  
 accompanying transportation and handling prior to use. Moreover, the rate of absorption is  
 55 substantially undiminished by the presence of a solidified structure enveloping the absorbent particles. The uptake of aqueous liquid is substantially instantaneous. This is wholly unexpected inasmuch as the presence of a carrier usually decreases the absorption rate.
- The absorbent products are useful as the sole or supplementary absorbent panel material in  
 60 absorbent articles such as bed pads, sanitary products, diapers, and incontinence pads. When the absorbent product is to be used as the sole absorbent panel, it may be applied directly to the ultimate substrate to be employed in the absorbent article, e.g., a diaper backing. Substrates  
 suitable for such purposes include films such as polyethylene film, non-woven cellulosic materials and wood-pulp materials. However, it may be employed in combination with wood-  
 65 pulp panels used in batting and with other absorbent materials while still having the effect of reducing size or thickness. The product not only has superior absorptive capabilities but has a soft feel and resilience thereby providing comfort without the thickness of conventional batting. A related application employing the absorbent product on a flexible substrate is in medical or  
 surgical dressings and sponges.
- The resilient and somewhat elastic nature of the foam product renders it also useful in

applications where both absorption and cushioning is desired such as in packaging, particularly for odd shape structures. Since the foam may be prepared from nontoxic materials, it is readily adaptable to foaming-in-place. However, the foam is stable and may be prepared in any size and shape, and stored with or without supporting structure. If desired it may be cut to the desired form for ultimate use.

An application of combined absorption and cushioning use is as a protective liner in dual-walled or dual containers for transporting aqueous fluids in which the inner wall or inner container is of breakable material such as glass used in transporting radioactive solutions or biological fluids. If the containers require special materials such as outer lead containers for radioactive fluids, it is desirable to reuse the lead container; the foam product is advantageous in being readily removable from the container by flushing the container with excess water.

The expression "absorbent" refers to water-insoluble, water-swellaable polymers as hereinafter described having an enhanced capacity for removing water or aqueous fluids. The water-insoluble, water-swellaable polymers are lightly cross-linked polymers containing a plurality of hydrophilic groups, such as carboxyl, carboxamide, sulfonate salt or hydroxyl groups, along the polymer chain in sufficient proportions so that the polymer would be water-soluble if it were not for the cross-linking thereof. In these polymers, the hydrophilic groups constitute at least twenty-five percent and up to seventy-two percent of their molecular structure. The materials are of sufficient molecular weight or degree of cross-linking to be water-insoluble while being water-swellaable. Many of the suitable materials are those which have been reported to have an average molecular weight per cross-linkage in the range of from 13,000 to 300,000, but are not limited thereto. The most common and best known of such materials are polyacrylate modified polysaccharides, cross-linked synthetic polyacrylates, cross-linked carboxymethylcelluloses or cross-linked poly(alkylene oxide)s as hereinafter defined. Other graft polymers of polysaccharides and natural gums such as xanthan gum, locust gum, guar gum and the like or blends thereof are also suitable provided they meet the requirements of water insolubility and water swellability. The water-insoluble, water-swellaable polymers have a gel capacity of at least about 10. By "gel capacity" is meant the weight of aqueous fluid which can be imbibed and held per unit weight of polymer, i.e., grams of fluid per gram of polymer. Stated another way, the absorbent polymers have an absorbent capacity of at least 10 times the weight of the material in dry form. The capacity may be up to 1500 times or more of the weight of the material in dry form; commonly it is about 15 to 70 times the dry weight. The materials are frequently spoken of in the art as "hydrogels", "hydrocolloids" or "superabsorbents". Many of the water-swellaable polymers are available commercially.

The polymers are used in particulate form. By "particulate" is meant a substance in the form of fine discrete particles. They may be variously shaped such as spherical, rounded, angular, acicular, irregular, or fibrous. The particles generally range in size from 1 micrometer to  $2 \times 10^4$  micrometres in diameter or cross-section (largest dimension when not spherical). The particles are preferably of finely divided powder of particles size of from 1 to  $10^3$  micrometers.

By "absorbent-immobilizing composition" is meant a composition containing a water-insoluble water-swellaable polymer in particulate form, a liquid polyhydroxy organic compound a blowing agent, if desired, minor amounts of non-essential additives hereinafter detailed. The composition is the vehicle for immobilizing particulate absorbent.

The liquid polyhydroxy organic compound employed in the present invention is a high boiling liquid having at least two vicinal or adjacent hydroxy groups. Suitable liquids include glycerol, ethylene glycol and propylene glycol. Glycerol and ethylene glycol are preferred.

The blowing agent in the foamable absorbent-immobilizing compositions may be any non-gaseous agent decomposing to form a gas and includes sodium bicarbonate and azo compounds, such as azodicarbonamide, p-toluenesulfonyl semicarbazide, p,p-oxybisbenzenesulfonyl hydrazide and p-toluenesulfonyl hydrazide. In certain aspects of the present invention, a non-foamable absorbent-immobilizing composition may be employed and the blowing agent may be a gas such as air, nitrogen or carbon dioxide.

In addition to the foregoing components, the composition may have included therein minor amounts of other additives which may impart desirable properties to the absorbent product.

Thus, a surface active wetting agent, particularly non-ionic surface active agent may be included to enhance liquid uptake. A surface active agent is of particular advantage in assisting vertical transport of liquids. Representative surface active agents are those commonly described such as alkyl aryl polyether alcohols or alkylphenyl ethers of polyethylene glycol, e.g., the reaction product of t-octylphenol or nonylphenyl with ethylene oxide. Fine fibrous cellulose such as cellulose flour, silicates and the like also have similar effect. Activated charcoal or other adsorbent may be included for odor uptake. Fragrance, coloring, etc., may be included for a pleasing effect. Inert materials containing bound water such as silicates and aluminum hydrate may be employed to modify the texture of the sheet. Similar results may be achieved employing slightly wet ethylene glycol or glycerol, e.g., commercial glycerine. If the absorbent immobilizing composition contains a low level of pulverulent absorbent, there is a slight tendency for the

absorbent to settle. The composition may be modified to include small quantities of materials to affect its spreading properties. Suitable viscosity modifiers include silicated powders, clays, zinc oxide and inert fillers. Also, the polyhydroxy compounds may be modified with minor amounts of liquid modifiers such as ether glycols, mineral oil, etc., not contemplated as the essential component of the instant compositions. Generally, the additives, if employed, do not constitute more than 25 percent of the total composition.

By "absorbent-bearing solidified structure" is meant the solid resulting on solidification of the liquid composition after application to a substrate or carrier surface, or to a metal or release coated surface for free foamed sheet formation, or after application to a container. When the absorbent bearing solidified structure is a foam sheet, it may be in the form of a continuous film or a discontinuous one; it may have a lattice-like form. Also, as hereinafter described, it may be in the form of a filament. The term "film" as herein employed contemplates a thickness up to 0.254 mm (10 mils) The term "sheet" contemplates a thickness greater than 10 (0.254 mm) 10 mils. Preferred structures are foam sheets.

When the absorbent bearing solidified structure is a foam, it may be prepared by mixing the components in any sequence to obtain an absorbent-immobilizing foamable composition and then subjecting the composition to foaming conditions to obtain the desired foam product. Thus, it may be prepared by first mixing together an appropriate water-insoluble, water-swellable polymer and blowing agent, thereafter adding a liquid polyhydroxy organic compound to the dry mixture and then stirring until homogeneous to obtain a foamable absorbent-immobilizing composition. Alternatively, the polymer and the liquid polyhydroxy organic compound may be mixed together and the blowing agent thereafter added to obtain a foamable absorbent immobilizing composition. A foam structure also may be prepared from a non-foamable composition as subsequently detailed.

Compositions of polymer absorbent in liquid polyhydroxy organic compound have time-limited fluidity and mobility. They are preferably prepared within several hours prior to use or at least within 24 hours but some absorbent-immobilizing compositions remain in the liquid form for longer periods.

The liquid absorbent-immobilizing composition then may be applied to a temporary or ultimate surface. The ultimate surface is hereinafter referred to as substrate. For making a foam, sheet or coated substrate, any method of application conventionally employed for coating or preparing films, e.g., knife-coating, spray-coating, reverse-roll coating, gravure-coating, cold extrusion coating or casting may be employed. Preferred methods are cold extrusion coating and knife-coating. The cold extrusion coating method may be employed to prepare a foam structure from the immobilizing composition which does not contain a particulate blowing agent. In this procedure, inert gas as blowing agent is injected downstream into the extruder chamber at a point where mixing has been completed to foam the mixture and to produce a viscous foamed extrudate which then may be coated in any manner. Another method of making a foam structure from an immobilizing composition which does not contain a blowing agent is to whip air into said composition and thereafter coating in any manner.

For making absorbent foam sheets or strips, a continuous process employing a cold extruder with a heated die is especially convenient. In this process the components, namely a particulate water-insoluble, water-swellable absorbent polymer, a liquid polyhydroxy organic compound and a blowing agent as essential components, together with a minor amount of wetting agent and other optional additives, are fed into an extruder and passed through the extruder barrel at ambient temperature to intimately mix the components, the mixture thereafter being forced into a die maintained in the temperature range from 93°C to 244°C (200°F to 400°F), whereupon blowing occurs with the formation of a solid foam product, and the foam product then being expelled through the die orifice onto a permanent or temporary substrate. The place for dispensing the blowing agent is dependent on whether a gaseous or non-gaseous blowing agent is employed. If a solid or liquid, it is fed into the hopper of the extruder. If a gas, it is injected at a point downstream in the extruder chamber. The die may be a single slot die if foam sheets are desired or a multi-slot die if strips are desired. The substrate may be the ultimate or permanent substrate in which case the foam layer is a foam coating on the substrate, or the substrate may be a temporary substrate such as a silicone liner if an unsupported foam sheet is desired.

When use as a coating on a substrate is contemplated, the substrate is of materials generally employed for absorbent articles, such as cellulose, vinyl films, polypropylene, polyester, polyethylene, nylon, metal foils, elastomers, cloth and nonwovens of various fibers. Coating on a substrate may be of the entire surface of the substrate, in strips or in any other pre-determined pattern. When use as a free foam sheet is contemplated, the coating may be made on material previously coated with a release agent such as silicone or on a metal surface. When the immobilized absorbent structure is to be used in an irregularly shaped device, the liquid composition may be poured into the irregularly shaped area. The coated substrate, the coated sheet-forming surface, or the foamable composition contained in an irregularly shaped device is then subjected to time-temperature related conditions to transform the liquid composition into a

solid immobilized absorbent foam structure.

The conversion of the liquid absorbent-immobilizing composition from a liquid-solid mixture to a solid foam may take place at a temperature up to 79°C (175°F) in a period as short as 15 minutes but more usually over a period from 30 minutes to 24 hours, or at elevated temperatures, 175°F to 450°F (79°C to 232°C), preferably about 275°F to 400°F (135°C to 204°C) for a period of from a few seconds up to 15 minutes. The foamable immobilizing composition may be placed in an appropriate vessel or onto a substrate or surface for foaming, and allowed to foam at the appropriate temperature. Where speed is desired, transformation of the liquid composition to a solid may be accomplished by exposure to heat in the range of about 200°F to 450°F (93°C to 232°C) for 1 to 60 seconds.

A factor affecting rate of solidification in addition to temperature is the amount of polymer absorbent. Compositions with high absorbent content, e.g., greater than about 50 parts per 100 parts of liquid polyhydroxy compound, solidify at ambient temperature in time measured in hours but with lower amounts of absorbent, there is increase in the time necessary for completion of a solidified structure formation. The solidified structure has been found to be more quickly formed from the more viscous liquid polyhydroxy compounds. However, the ultimate polymer absorbent content of the solidified structure is generally lower with the more viscous polyhydroxy compound since it is difficult to form a homogeneous composition. Thus, for example, a foam obtained from glycerol as polyhydroxy compound generally has less absorbent than that from ethylene glycol as polyhydroxy compound. However, as previously indicated, for maximum absorptive efficiency of the ultimate product, it is desirable that the liquid polyhydroxy compound be the major component. Preferred films or sheets are those containing from 40 to 80 parts by weight of absorbent per 100 parts by weight of polyhydroxy compound.

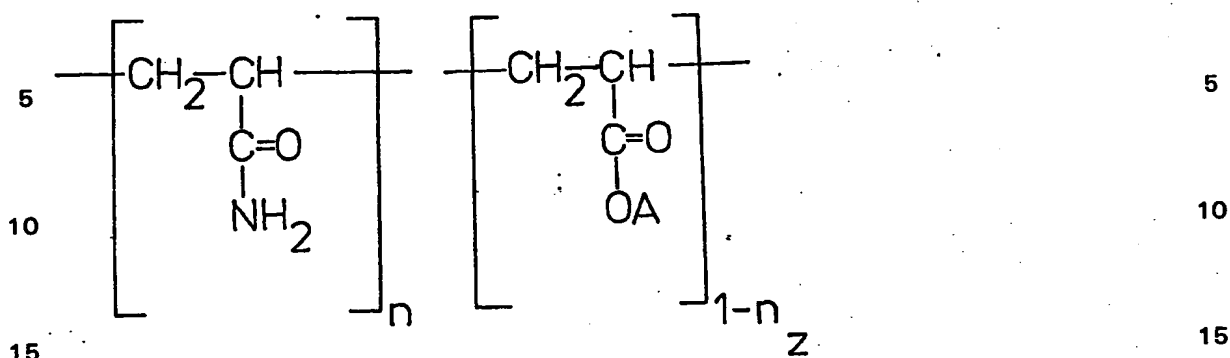
The particulate absorbent in the absorbent-bearing solidified structure is firmly retained in the film or lattice and is not subject to moving or shifting in the ultimate absorbent article and retains all the high absorptive capacity of the particulate absorbent.

The liquid absorbent-immobilizing composition in addition to being useful as starting material for the solidified absorbent bearing film or structure above described, is also useful in the liquid form and may be applied to dressings, skin, body exudates as well as to aqueous liquids from other sources.

Many water-insoluble, water-swellaible polymers suitable as absorbent are available commercially. They also may be prepared by cross-linking a pre-formed water-soluble, straight chain polymer, by polymerizing an appropriate monomer or a monomer with a co-monomer to effect simultaneous polymerization and cross-linking, or by incorporating a hydrophilic group into a completed polymer. An example of a later incorporation of a hydrophilic group to the completed polymer is the incorporation by sulfonation of a sulfonic acid moiety. When it is desired to have the hydrophilic group in the salt form, the polymer may be prepared first as an acid, ester, amide, or nitrile and the product hydrolyzed in whole or in part.

The preferred polymers have an acrylate group in their molecular structure. They may be completely synthetic acrylate polymers or acrylate modified polysaccharides, e.g., acrylate modified starch or acrylate modified cellulose. By "acrylate modified" is meant that an acrylate polymer or polyacrylate as hereinafter described has been grafted onto the polysaccharide. "Acrylate polymer" or "polyacrylate" as herein employed embraces not only polymers which contain acrylate salt groups but those which also may contain an acrylamide, acrylic acid, acrylic ester group or acrylonitrile group.

The preferred synthetic acrylate polymer absorbents are those which have a salt group, an acid group, or which have both an amide group and a salt or acid group. These have been represented in the literature, e.g., U.S. Patent 3,686,024, by the following formula:

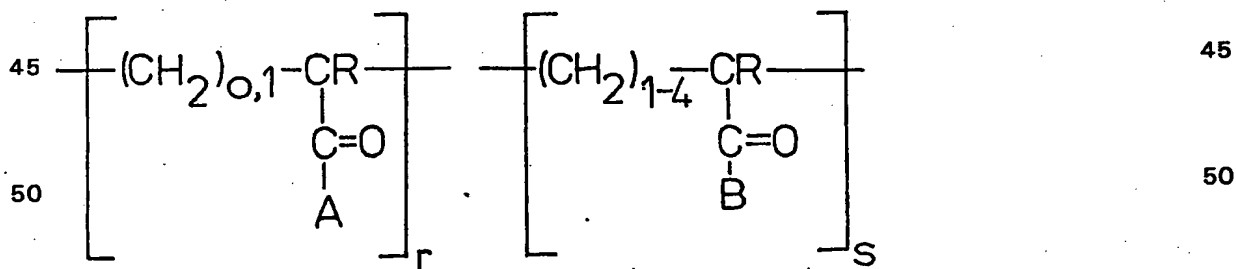


where A is an alkali metal ion such as sodium or potassium, or is hydrogen,  $n$  is from 0.5 to 0.9,  $1 - n$  defines the extent of hydrolysis, and  $z$  is the number of mer units between crosslinks.

The polyacrylate absorbent containing both amide and carboxylate groups may be prepared either (1) by aqueous polymerization of acrylamide with a difunctional organic cross-linker such as N,N'-methylenebisacrylamide in the presence of a free radical catalyst to obtain a water-swellaible, cross-linked polyacrylamide, followed by partial hydrolysis in aqueous alkali to obtain a cross-linked polymer having both an amide and an alkali metal carboxylate groups as more fully described in U.S. Patent 3,247,171, or (2) by copolymerization of acrylamide and acrylic acid alkali metal salt in the presence of a cross-linking monomer such as N,N'-methylenebisacrylamide and a catalyst system such as 1:1 ammonium persulfate and  $\beta$ -dimethyl-aminopropionitrile, also described in the aforesaid patent, or (3) by radiation polymerization and cross-linking as described in U.S. 4,192,727.

Polyacrylate absorbents also may be prepared by subjecting linear polyacrylate to high energy radiation cross-linking as described in U.S. Patent 3,229,769, or to chemical polymerization and cross-linking as described in British Patent 719,330, or may be prepared by cross-linking of a previously prepared polyacrylamide.

35 Acrylate modified polysaccharides are those which have a polyacrylate chain grafted onto a cellulose or starch molecule. They are preferred graft copolymers of polysaccharides which have hydrophilic chains grafted thereon. By "hydrophilic chain" is meant a polymer chain obtained from monomers which have a group which is water-soluble or becomes water-soluble on hydrolysis, e.g., carboxyl, sulfonic, hydroxyl, amide, amino, quaternary ammonium and hydro-  
40 lysis products thereof. In the polysaccharides acrylate polymers, a hydrophilic chain of the general formula



55 is attached to the backbone of the cellulose or starch molecule through a carbon linkage. In the formula,



independently represents an acid, ester, alkali metal, ammonium salt or amide group, each R independently is hydrogen or lower alkyl, r is an integer of from 0 to 5,000 and s is an integer of from 0 to 5,000, and r + s is at least 500.

65 The polysaccharide acrylate polymers may be prepared employing well known procedures for

carrying out graft copolymerization of olefinically unsaturated chains onto cellulose and starch in which grafting of the hydrophilic material onto a starch or cellulose backbone is accomplished simultaneously with the formation of the hydrophilic polymeric material, and, if necessary, followed by hydrolysis. Thus, the polymers may be prepared by the polymerization of an

5 appropriate polysaccharide with an appropriate acrylic monomer such as acrylonitrile, methacrylonitrile, methyl or ethyl acrylate, acrylic or methacrylic acid, or with acrylamide or methacrylamide, followed by alkaline hydrolysis or by the polymerization of alkali metal salt of acrylic or methacrylic acid with the appropriate polysaccharide. 5

The polymerization is carried out in the presence of a free radical catalyst system in an aqueous medium, or by irradiation (ultra-violet, gamma-, or X-radiation). Catalyst systems for employment in aqueous media usually comprise an inorganic oxidizing agent as initiator and an inorganic reducing agent as activator. Representative oxidizing agent initiators are inorganic persulfates, peroxides and alkali metal bromates and chlorates. Representative reducing agent activators are alkali metal bisulfites, sulfites, ferrous ammonium sulfate, and alkali metal thiosulfate. 10 15

In a method for carrying out graft polymerization employing a catalyst system, the inorganic oxidizing agent initiator and the inorganic reducing agent activator each as an aqueous solution are alternately added to a reaction medium comprising a water-solution of an acrylate monomer, a co-monomer, a cross-linking monomer, and a dispersion of pulverulent or fibrous water-insoluble water-swellaable polysaccharide in water-immiscible organic liquid containing a minor amount of water-miscible solvent to obtain an acrylate modified polysaccharide product as more fully described in U.S. Patent 4,028,290. Other suitable methods for chemical catalytic graft polymerization may be found in U.S. Patent 3,256,372; 3,661,815; 4,076,663; 3,889,678 and 4,105,033. 20 25

Suitable polysaccharide acrylate polymers are those in which the hydrophilic chain loading on the backbone is in the range of from 10 percent by weight to 90 percent by weight, usually from 40 to 80 percent by weight of the polysaccharide acrylate polymer. 25

Other suitable water-insoluble, water-swellaable polymers include cross-linked carboxymethyl-cellulose (CMC) obtained as described, for example, in U.S. Patent 2,639,239, cross-linked poly(alkylene oxide) of molecular weight of at least 100,000, obtained as described, for example, in U.S. Patent 3,956,224; 3,264,202; 3,957,605 and 3,898,143; and blends of organic substances of polysaccharide character, e.g., natural or synthetic gums. It has been found generally that when gums are employed they must be employed as blends. It appears that the polysaccharide gums which are normally soluble interact when employed as blends to have the desirable swellability without the undesirable solubility. Typical gums which may be employed in blends include locust bean gum, guar gum, xantham gum, tragacanth gum, karaya gum and the like. Gum blends as well as the absorbent polymers above described are available commercially under various trade names. 30 35

The water-insoluble, water-swellaable polymers prepared by any of the foregoing methods are generally obtained as stiff, brittle solids. These may be comminuted to the appropriate size. Preferably they are employed in the form of powder as previously defined, but may also be employed in other forms. 40

The liquid polyhydroxy compounds which are suitable from the currently available hydroxy compounds are quite limited and are substantially as previously defined. Commercial grades of vehicles are appropriate. It is not necessary to subject them to drying prior to use. Although liquids such as propylene glycol are operable in forming the desired film, the slowness in forming the film renders them less desirable in the invention directed to a process for immobilization. 45

When the solidified structure is a foam sheet, it may be only part of a moisture receiving component of the absorbent article. However, as previously indicated, it may be obtained as a free foam sheet and be employed in the ultimate absorbent article to constitute the entire moisture receiving portion thereof. It may be used wherever a dessicant is necessary. 50

The absorbent product as a free absorbent film or sheet is preferably formed by casting on a metal surface or coating on a silicone or other release agent covered surface the liquid absorbent-immobilizing composition and allowing the liquid composition to solidify either by heating at temperatures of from 79°C to 232°C (175°F to 45°F) for from a few seconds to 15 minutes or standing at temperature up 79°C (175°C) for from 30 minutes to 24 hours. The absorbent product as a coating on a substrate is formed by coating on the ultimate substrate under similar conditions. 55

The absorbent product as a solidified structure may be in the form of filament or rope. Such form may be achieved readily by metering absorbent and polyhydroxy compound into a cold extruder with the die heated to a temperature in the range of 79°C to 232°C (175°C to 450°F) and recovering the extruded filament or rope. 60

When the absorbent foam product is to be employed as a protective liner of a dual-walled container, the liquid immobilizing absorbent composition is poured into the area between the 65

TABLE A

5 Component	Amount of Components (parts by weight) Examples								5
	I	II	III	IV	V	VI	VII	VIII	
<i>Absorbent</i>									
10 Starch Polyacrylate (SPC 502S, Henkel)							50		10
Starch Polyacrylate (Stasorb®, A.E. Staley)						50			
15 Cross-linked Ionic Polyacrylate (Permasorb® AG, National Starch)	50	75	50						15
Polyacrylate (Sanwet®, Sanyo)					50				
Polyacrylate (Aqua-Keep, Mitsubishi)				50					
20 Cellulose Polyacrylate*								50	20
<i>Polyhydroxy Compound</i>									
Glycerol	100		100	100	100				
Ethylene Glycol		100				100	100	100	
<i>Blowing Agent</i>									
25 Celogen® OT <sup>1</sup>			5						25
Celogen® TSH <sup>2</sup>				5				5	
Celogen® AZ <sup>3</sup>					5		5		
Sodium Bicarbonate	5	10				5			

30 \*Prepared according to U.S. Patent 3,889,678

<sup>1</sup> p,p'-Oxybisbenzene sulfonyl hydrazide; <sup>2</sup>p-Tolene sulfonyl hydrazide; <sup>3</sup>Azodicarbonamide; all products of Uniroyal Chemical

35 In separate operations, portions of each composition are treated in the following manner: (a) knife-coated onto a release-coated paper, (b) knife-coated onto a polyethylene film, and (c) poured into the space between the inner glass and outer metal walls of a dual-wall container until about one-tenth of the space is filled. The treated compositions are allowed to stand at ambient temperature whereupon foaming occurs in a few hours and there are obtained (a) foam sheets from the compositions which have been knife-coated onto release coated paper; (b) foam-coated film from compositions which have been knife-coated onto polyethylene film; and (c) foam in the space near the bottom portion of the double wall container.

The operation is repeated except that the treated samples are exposed to a temperature of 135°C (275°F) for ten seconds to obtain the corresponding foam products.

45 When 100 grams of water is applied to foam (10 gram size) in each of the foregoing examples, the foam swells instantaneously taking up the water substantially completely.

#### EXAMPLE IX

50 A foamable composition is prepared by mixing together at ambient temperature 80 parts of starch polyacrylate (Stasorb®) and 5 parts of sodium bicarbonate, and then adding and mixing 100 parts of glycerol. In separate operations, the composition is knife-coated onto (a) non-woven cellulosic fabric, (b) polyethylene film, and (c) thin layer of wood pulp material as substrates. The coated substrates are exposed to a temperature of 150°C (300°F) for a few seconds to obtain foam coated substrates. The foam coated substrates are then slit into sizes suitable for absorbent articles.

55 When water is applied to the articles comprising foam coated substrates, there is instantaneous removal of free-standing water and swelling of the foam.

#### CLAIMS

60 1. An absorbent-immobilizing, foam-forming composition in liquid form, for use in preparing a product capable of absorbing and retaining large quantities of fluid, comprising:

a) at least 25 to no greater than 1.25 parts by weight of a particulate, water-insoluble, water-swellaible absorbent polymer having a gel capacity of at least ten, provided that the polymer is not a hydrolysed starch polyacrylonitrile graft copolymer;

65 b) 100 parts by weight of a liquid polyhydroxy organic compound having vicinal hydroxy groups; and



container walls and allowed to stand at ambient temperature or heated as for the foam sheets.

The actual amounts of absorbent in the compositions within the scope previously indicated is dependent on the level of absorption required in the ultimate environment. Thus, if the

- 5 absorbent immobilizing composition will contain absorbent sufficient to supply the desired  
absorptive capacity to the pad substrate. The products and processes are useful in the  
manufacture of numerous absorbent articles. They are especially useful where reduction in bulk  
of absorbent as well as high capacity is desirable, such as in articles to be worn. Thus, they are  
10 particularly useful for diapers and incontinence pads, but also for sanitary napkins and  
bandages. 5 10

- In use in diapers, the absorbent product may be as a sole absorbent or as a component  
improving the quality of the existing absorbent. In the manufacture of diapers in which the foam  
product is incorporated as an improvement to the liquid receiving portion of the diaper, the  
composition is applied to the surface of the aqueous liquid receiving portion of the article,  
15 namely the batting, the coated batting subjected to a heating cycle or to standing at  
temperatures up to 79°C (175°F) and the resulting modified batting provided with moisture  
impermeable backing and a moisture permeable top sheet. Alternatively, the absorbent  
immobilizing composition may be coated on a conventional non-absorbent moisture impermea-  
ble diaper backing without batting and thereafter laminated with a conventional moisture  
20 permeable top sheet to provide a thin diaper. Other techniques within the skill of those to whom  
the invention is directed may be employed to obtain new absorbent diapers. 15 20

In the case of sanitary napkins, the absorbent immobilizing composition may be applied to the  
cellulosic absorbent surface and wrapped in a conventional manner to produce a napkin of  
improved absorptive capacity.

- 25 In the case of bandages, the absorbent composition may be coated onto an aqueous liquid  
permeable but a gel impervious material, e.g., non-woven fabrics such as of rayon or polyester  
fabrics, and then inserted in the gauze bandage. 25

The following examples illustrate the invention but are not to be construed as limiting:

30 **EXAMPLES I-VIII** 30

Foamable compositions as set forth in Table A are first prepared by first mixing together at  
ambient temperature the appropriate absorbent and blowing agent, thereafter adding the  
appropriate liquid polyhydroxy organic compound, and mixing to a smooth dispersion.

- c) 2 to 30 parts of a blowing agent.
2. A composition according to claim 1, comprising from 40 to 80 parts of the particulate absorbent polymer.
3. A composition according to claim 1 or claim 2, wherein the particulate absorbent polymer is starch polyacrylate. 5
4. A composition according to claim 1 or claim 2, wherein the particulate absorbent polymer is cellulose polyacrylate.
5. A composition according to claim 1 or claim 2, wherein the particulate absorbent polymer is polyacrylate.
6. A composition according to any one of claims 1 to 5 wherein the liquid polyhydroxy compound is glycerol. 10
7. A composition according to any one of claims 1 to 5 wherein the liquid polyhydroxy compound is ethylene glycol.
8. An absorbent film or sheet product prepared by coating or casting a composition according to any one of claims 1 to 7, and thereafter subjecting the coated or cast liquid to conditions for solidification by allowing it to stand at a temperature up to 79°C (175°F) for 30 minutes to 24 hours or heating at a temperature from 79°C to 232°C (175°F to 450°F) for from a few seconds up to 15 minutes. 15
9. An absorbent foam product prepared by allowing a composition according to any one of claims 1 to 7 to foam. 20
10. An absorbent article comprising a foam coated substrate, said foam coated substrate being obtained by coating a composition according to any one of claims 1 to 7 onto the substrate and allowing the composition to foam.
11. A product according to claim 9, prepared by allowing the composition to stand at ambient temperature for from 1 hour to 24 hours. 25
12. A product according to claim 9 or an article according to claim 10, prepared by subjecting the composition to a temperature in the range from 79°C to 232°C (175°F to 450°F) for from a few seconds to a few minutes.
13. An article according to claim 10 or claim 12, wherein the substrate is a polyethylene film. 30
14. An article according to claim 10 or claim 12, wherein the substrate is a non-woven cellulosic fabric.
15. An article according to claim 10 or claimed 12, wherein the substrate is a layer of wood pulp material.
16. A dual walled container for transporting aqueous fluids having a breakable inner wall and a non-breakable outer wall and having in a portion of the space between the two container walls a foam prepared by allowing a composition according to any one of claims 1 to 7 to foam. 35
17. A process for decreasing the mobility of a particulate absorbent in an absorbent article and improving moisture transport therein, which comprises applying an absorbent-immobilizing composition according to any one of claims 1 to 7 onto a substrate or casting surface as a liquid layer to form a liquid film and thereafter subjecting the liquid to solidifying conditions for a time sufficient to transform the liquid film into an absorbent bearing solidified structure. 40
18. A process according to claim 17, wherein the liquid film is heated at a temperature in the range of from 79°C to 232°C (175°F to 450°F) for from 1 to 60 seconds.
19. A process according to claim 17, wherein the liquid film is allowed to stand at ambient temperature for from 60 minutes to 24 hours. 45
20. A process for producing an absorbent foam product comprising:
- (1) feeding into an extruder the components of a composition according to any one of claims 1 to 7;
- (2) passing the components through the extruder barrel at ambient temperature to intimately mix the components; 50
- (3) forcing the resulting mixture into a die maintained at a temperature in the range 93°C to 204°C (200°F to 400°F) to cause foam formation; and
- (4) expelling the foam product through the orifice of the heated die onto a temporary or permanent substrate. 55
21. A process according to claim 20, wherein the foam product is expelled onto a permanent substrate to produce a foam coated absorbent article.
22. A process according to claim 20, wherein the foam products is expelled onto a temporary substrate to produce a self-supporting foam sheet or strip.
23. A foam forming composition, substantially as hereinbefore described in any one of the foregoing Examples. 60
24. An absorbent foam product substantially as hereinbefore described in any one of the foregoing Examples.
25. A method of producing an absorbent foam product, substantially as hereinbefore described in any one of the foregoing Examples. 65

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